PTO 09-1999

CC=JP
DATE=19990602
KIND=A
PN=11149073

AREA LIGHT SOURCE DEVICE AND LIQUID CRYSTAL DISPLAY DEVICE
[MENKOGEN SOUCHI OYOBI EKISHO HYOJI SOUCHI]

HIDENORI KUNISHIGE

UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. JANUARY 2009
TRANSLATED BY: SCHREIBER TRANSLATION, INC.

PUBLICATION COUNTRY	(10):	JP
DOCUMENT NUMBER	(11):	11149073
DOCUMENT KIND	(12):	A
PUBLICATION DATE	(43):	19990602
APPLICATION NUMBER	(21):	9-316754
APPLICATION DATE	(22):	19971118
INTERNATIONAL CLASSIFICATION	(51):	G02F 1/1335; F21V 8/00; G02B
PRIORITY COUNTRY	(33):	N/A
PRIORITY NUMBER	(31):	N/A
PRIORITY DATE	(32):	N/A
INVENTOR(S)	(72):	HIDENORI KUNISHIGE
APPLICANT(S)	(71):	MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
DESIGNATED CONTRACTING STATES	(81):	N/A
TITLE	(54):	AREA LIGHT SOURCE DEVICE AND LIQUID CRYSTAL DISPLAY DEVICE
FOREIGN TITLE	[54A]:	MENKOGEN SOUCHI OYOBI EKISHO HYOJI SOUCHI

[Claims]

1. An area light source device, comprising:

a straight tube type light source;

a pair of light guide plates, which face to each other being a certain distance away from said light source and share one same face by the faces that are perpendicular to the faces that face to the light source;

a light diffusing means provided between said pair of light guide plates and face to the light source being a certain distance away from the light source; and

a reflecting means.

2. The area light source device according to Claim 1, wherein said light diffusing means is made of a light transmitting material in which a material with different refractive index are mixed, and has a reflective dot pattern formed on a surface that faces said light source.

3. The area light source device according to Claim 1 or 2, wherein said surface of said light diffusing means, which faces the light source, includes two oval curved surfaces, one focus of each oval is the center point of the light source and other focus is a point that is shortest distance away from the center point of the light source on the

surface that faces the light source of the light guide plates.

4. The area light source device according to Claim 1 or 2, wherein a reflective surface of said light reflecting means is a surface that faces the light source and the points that are shortest distance away from the light source is parallel to an axial direction of the light source, and protrudes towards the light source side.

5. An area light source device, comprising a plurality of light source modules, wherein each of said light source modules comprises:

a straight tube type light source;

a pair of light guide plates that face to each other being a certain distance away from the light source and share one surface by the faces that face to said light source; and

a light diffusing means that is provided between said pair of light guide plates so as to be over the shared surface of the pair of light guide plates,

said plurality of light source modules are arranged to be parallel to axial directions of said light sources and to have the shared surfaces of the light guides plates on a same surface, and a light reflecting means is provided over

the whole light guide plates on the opposite side to the shared surfaces of the light guide plates.

6. The area light source device according to Claim 5, wherein said light reflecting means has its reflecting face on the face that faces to said light sources and is away from said light guide plates, and have the points, which are shortest distance away from each light source, being parallel to the axial direction of the light source, and protrudes forming an inverse V-shape towards the light source side.

7. The area light source device according to Claim 5, wherein a face of each light guide plate, which is on the other side of a face that faces the light source, contacts with a face of adjacent light guide plate in a light source module, which is on the other side of a face that faces the light source.

8. A liquid crystal display device, comprising:

a plurality of light source modules, each of said light source modules comprises:

a straight tube type light source;

a pair of light guide plates that face to each other being a certain distance away from the light source and share one surface by the faces that face to said light source; and

a light diffusing means that is provided between said pair of light guide plates so as to be over the shared surface of the pair of light guide plates,

wherein said plurality of light source modules is arranged and supported so as to be parallel to axial directions of the light sources and share one same surface by the shared surfaces of the respective pairs of the light guide plates;

a liquid crystal panel, in which transmission type liquid crystal display elements are arranged in matrix on the shared surface side; and

a light reflecting means provided on the other side of the shared surface of the light source modules,

wherein the arrangement pitch of the light source module is integral multiple of picture element pitch of said liquid crystal panel.

9. The liquid crystal display device according to Claim 8, wherein the connecting sections between the adjacent light source modules are positioned at non-picture element positions of the liquid crystal panel.

10. The liquid crystal display device according to Claim 8 or 9, further comprising an energizing means to energize in a direction to widen space between a pair of light guide plates of the light source modules.

[Detailed Description of the Invention]

The present invention relates to an area light source device used in a backlight for a lighting display, a liquid crystal display, or the like.

[0002]

[Field of the Invention]

Conventionally, as an area light source device used in a backlight of a liquid crystal display, typical ones are direct lighting type, which includes a light source arranged within a display area on the backside of a liquid crystal panel and lights right above with direct light from the light source; and an edge type which includes a light source outside of the display area on the back side of the liquid crystal display, and irradiates guiding light with a light guide plate made of transparent acrylic resin, etc. to the display area.

[0003]

In this area light source device, since there is limit in the area that can be irradiated with a single light source, a technique using a plurality of light sources has been suggested for increased size and brightness in recent display screens.

[0004]

As an example of a direct lighting type, for example, there is one in which a plurality of light sources is arranged so as to be provided at certain intervals being parallel to each other as disclosed in Japanese Unexamined Patent Application Publication H7-141908. However, in case of this type, the brightness is high right above the light source, striped uneven brightness is easily generated, and it is necessary to increase the distance between the panel and the light source, so that there is a problem of large thickness of the device.

[0005]

Furthermore, as an example of an edge type, there are ones as disclosed in Japanese Unexamined Patent Application Publication H8-36178 or H9-90135, in which light sources are arranged around a light guide plate or a plurality of light sources are arranged at the end surface of a light guide plate. However, in these devices, there is a problem of large non-display area around a display screen or large thickness of a light guide plate and thereby increased weight of the whole device.

[0006]

In addition, light radiated from the light source is reflected by a lamp reflector that guides the light to an

incident end surface of the light guide plate, but most part is shielded by a light source and the use efficiency of the light radiated from the light source is low.

[0007]

Furthermore, there is a technique, in which a direct lighting type and an edge type are combined and a light source is provided right under a panel and diffused by a light guide plate, which is disclosed, for example, in Japanese Unexamined Patent Application H9-61821.

[0008]

As shown in Fig. 7, in this technique, a recess is provided at the center part on the lower face of the light guide plate, a light source is provided at the recess, and a dot pattern for light diffusion is printed on the lower surface and recess of the light guide plate.

[0009]

[Problems to be Solved by the Invention]

In the above-described techniques, however, there are various problems to light a large screen at high brightness.

[0010]

A thin and long light source tends to be easily displaced by vibration or skew. If a shape of an incident plane of a light guide plate that faces a light source is curved or a polygonal shape, by displacement of the light

source, the brightness distribution from the light guide plate changes and causes uneven brightness.

/3

[0011]

Furthermore, in order to increase the number of light sources for higher brightness or displaying on a larger screen, for example, it has been proposed to dispose a plurality of light sources in a recess, or form a plurality of recesses under a light guide plate and dispose a light source in the respective recesses. However, if a plurality of light sources is disposed, the thickness of the light guide plate increase and thereby becomes heavier. Moreover, if a plurality of recesses is provided, strain, skew, and cracks are easily generated upon fabrication such as molding, and there is a challenging such as handling upon assembly.

[0012]

In addition, if a recess is formed right under the center part of a light guide plate and a light source is placed therein, the light emitting face is distorted by heat from a light source and thereby the displayed image may be adversely affected.

[0013]

An object of the invention is to provide an area light source device that is thin, light-weighted, and inexpensive even for displaying at high brightness on a large screen.

[0014]

[Means to Solve the Problems]

In order to attain the above object, the present invention is characterized by having an area light source device, which comprises: a straight tube type light source; a pair of light guide plates, which face to each other being a certain distance away from the light source and share one same face by the faces that are perpendicular to the faces that face to the light source; a light diffusing means provided between said pair of light guide plates and face to the light source being a certain distance away from the light source; and a reflecting means.

[0015]

Furthermore, the present invention is characterized by having an area light source device, which comprises: a straight tube type light source; a pair of light guide plates, which face to each other being a certain distance away from the light source and share one same face by the faces that are perpendicular to the faces that face to the

light source; a light diffusing means provided between said pair of light guide plates and face to the light source being a certain distance away from the light source; and a reflecting means. The surface of the light diffusing means, which faces a light source, includes two oval curved surfaces having a focus at the center point of the light source, and a focus at a point that is in shortest distance away from the center point of the light source on a surface of the light guide plates that face to the light source, and the face of the light reflecting means, which faces the light source, has a shape that protrudes to the light source side at a position that is in shortest distance from the light source.

[0016]

In addition, the present invention that attains the above object is characterized by including a plurality of light source modules, each of which includes: a straight tube type light source; a pair of light guide plates that face to each other being a certain distance away from the light source and share one surface by the faces that face to the light source; and a light diffusing means that is provided between the pair of light guide plates so as to be over the shared surface of the pair of light guide plates. The plurality of light source modules are arranged to be

parallel to axial directions of said light sources and to have the shared surfaces of the light guide plates on a same surface, and a light reflecting means is provided over the whole light guide plates on the opposite side to the shared surfaces of the light guide plates.

[0017]

Furthermore, the present invention is characterized by having a plurality of light source modules, each of which includes: a straight tube type light source; a pair of light guide plates that face to each other being a certain distance away from the light source and share one surface by the faces that face to the light source; and a light diffusing means that is provided between the pair of light guide plates so as to be over the shared surface of the pair of light guide plates. The plurality of light source modules is arranged and supported so as to be parallel to axial directions of the light sources and share one same surface by the shared surfaces of the respective pairs of the light guide plates. The device of the invention further includes a liquid crystal panel, in which transmission type liquid crystal display elements are arranged in matrix on the shared surface side; and a light reflecting means provided on the other side of the shared surface of the light source modules. The arrangement pitch

of the light source module is integral multiple of picture element pitch of said liquid crystal panel.

[0018]

The invention is further characterized by positioning the connecting sections between the adjacent light source modules to non-picture element positions of the liquid crystal panel.

[0019]

With the above-described configuration, a module is composed from a light source and a pair of light guide plates. By arranging a plurality of the modules in parallel, a large screen can be lit and a thin and light area light source device can be provided.

[0020]

In addition, since a part of the light radiated right above from the light source is guided to a reflector by a light diffusing means without being shielded by the light source, travels through space between the light guide plates and the reflector, and then enters again the light guide plates, the use efficiency can be significantly improved and lighting with high brightness can be achieved.

[0021]

Furthermore, arranging a plurality of light source modules in parallel and setting the connecting sections to

non-picture element positions of the liquid crystal display, a big screen liquid crystal display device can be provided without impairing the visibility.

[0022]

[Embodiments of the Invention]

Hereunder, a first embodiment of the invention will be described referring to the drawings.

[0023]

Figs. 1 and 2 show a structure of the invention; and Fig. 3 shows a detailed structure of a light source unit.

[0024]

[1] is a display panel on which a transmitted image is printed on a transparent film resin or the like; and [2] is a support frame to support the display panel [1], and a light source unit is placed therein.

[0025]

The light source unit includes a long light source [3]; a pair of light guide plates [4] and [5] that diffuse light radiated in the left and right direction from the light source [3] to the whole display region of the display panel [1]; a diffusing member [6] that transmits and diffuses light radiated in the upper direction from the light source [3]; and a reflector [7] that reflects light that is in a direction opposite to the display panel [1].

[0026]

The light source [3] is a straight tube type such as a cold cathode fluorescent tube, has both ends supported by a support frame [2] so as to be freely attached/detached, and lit up by a driving circuit that is not illustrated.

[0027]

The pair of light guide plates [4] and [5] is rectangular flat plates made of a transparent material such as acrylic resin. The light guide plates are supported by the support frame [2], having incident faces [4a] and [5a] on the both sides of the light source [3] being a certain distance away therefrom and emission faces [4b] and [5b], which are perpendicular to the incident faces [4a] and [5a], so as to form one same surface.

[0028]

Faces [4c] and [5c] of the light guide plates, which are opposite to the emission faces [4b] and [5b], are sloped to be thinner in the outward direction from the light source [3] and form a fine V-shaped groove that emits to the emission faces [4a] and [5a] the light that propagates inside the light guide plates [4] and [5].

[0029]

The V-shaped groove formed as described above is parallel to an axial direction of the light source [3]. If

the arrangement pitch is smaller, striped unevenness of brightness on the emission faces [4b] and [5b] of the light guide plates is less, and the visibility is improved, but it is set within range of 200 to 500 μm in view of the processability. The groove width is 1/2 to 1/5 of the arrangement pitch and is preferably set to be larger in the outward direction from the light source [3] so as to achieve uniform emission brightness distribution of the light guide plates.

[0030]

The diffusing member [6] is made of a light diffusing material, for example, a transparent acrylic resin with a material having different refractive index diffused therein. The diffusing member [6] is disposed in the space between the pair of light guide plates [4] and [5] above the light source [3] and have the both ends at the ends of the emission faces [4b] and [5b] of the pair of light guide plates.

[0031]

In addition, a face of the diffusing member [6], which faces the light source [3], has a W-shape composed of two concave surfaces. Each concave surfaces has an oval shape, has one focus on the center point O of the light source and other focus [P1], [P2] on a horizontal axis that is in a

shortest distance from the light source on the emission faces [4a] and [5a] of the light guide plates [4] and [5].

[0032]

In addition, a material having reflecting and diffusing property is formed in a dot pattern on the concave surfaces, for example, by printing. This dot pattern is to prevent higher brightness right above the light source [3] and partially shields light from the light source [3].

[0033]

Here, by forming a denser dot pattern toward the light source [3], the reflected light can be increased and the emitting light onto the panel [1] side can be made uniform.

[0034]

Furthermore, uneven brightness due to birefringence tends to occur at the edges of the emission faces [4b] and [5b] of the light guide plates, where a diffusing member [6] is mounted on, on the light source side, but the brightness can be uniformed by forming a dot pattern on a surface that contacts with the diffusing member [6].

[0035]

The reflector [7] is a thin metal plate made of aluminum or the like, is provided on the backside of the pair of light guide plates [4] and [5], and have a metal

film of aluminum, silver, or the like vapor-deposited on the face that faces the light guide plates [4] and [5].

[0036]

Both side edges of the reflector [7] are adhered to the faces [4d] and [5d] that are opposite to the incident faces of the pair of the light guide plates, and form space layer being away from the faces [4c] and [5c] opposite to the emission faces of the light guide plates.

[0037]

In addition, inversed V-shaped protrusion [7a] that is parallel to the axial direction of the light source is provided right under the light source [3] on the bottom face of the reflector [7], and is sloped under the both ends of the pair of light guide plates in a direction of narrower space layer.

[0038]

Next, operation of an area light source device configured as described above will be described. The light source [3] such as a cold cathode fluorescent tube emits light in any direction from an inner wall surface of the tube, but it will be described by an illustrative diagram with reference to the center of the light source. In Fig. 4, among radiated lights from the light source, the light at angle φ1 that faces the incident faces [4a] and [5a] of

the light guide plates enters the light guide plates [4] and [5], the light at angle φ2 in the upper direction that does not face the light guide plates travels to the diffusing member [6], and the light at angle φ3 in the lower direction travels to the reflector [7].

[0039]

The light entered the light guide plates [4] and [5] travels repeating total reflection, and is emitted from the emission faces [4b] and [5b] being refracted by the V-shaped groove of the faces [4c] and [5c] opposite the emission faces.

[0040]

The light to the diffusing member [6] is divided into light reflected by the reflection dots and light transmitted. While the transmitted light is emitted in a direction of the panel [1], the reflected light travels through the space between the light source [3] and the light guide plates [4] and [5] and guided to the reflector [7] thereunder.

[0041]

The light radiated in the lower direction from the light source [3] changes its light path at the sloped face of the inverse V-shaped protrusion [7a] of the reflector [7] with light reflected at the diffusing member [6]. Then,

the light travels in the both edge directions of the light guide plates [4] and [5] through the space layer, is reflected at the sloped face [7b] of the both edges of the reflector [7], emits from the faces [4c] and [5c] that are opposite to the emission faces of the light guide plates, and then emitted in the direction of the panel [1].

[0042]

As described above, the light radiated from the light source [3] may be attenuated by a few times of reflection, but is guided in the direction of the panel [1] without absorption by the light source [3].

[0043]

If the space between the pair of the light guide plates [4] and [5] is narrower, the angles φ1 and φ2 become larger and amount of the incident light becomes increased. However, because of a path for the light at angle φ3 reflected by the diffusing member [6], the space is preferably set to 1.5d to 2d for a diameter d of the light source [3].

[0044]

Furthermore, the amount of incident light is increased if the thicknesses of the incident faces of the light guide plates are larger. When acrylic resin is used as the light guide plates, the refractive index is 1.49 and the incident

angle of the light that is total-reflected and propagates in the light guide plates is about 42°, and the angle φ1 to the center of the light source is preferably set to about 90°.

[0045]

The example specifically stated above is an embodiment of the invention, and may be modified within the scope of the invention. In the above example, the V-shaped groove formed on the light guide plates [4] and [5] is arranged at constant intervals and set to have larger groove width proportional to the distance from the light source [3]. Alternatively, for example, the even if the groove width is set constant and the space is set small proportional to the distance from the light source [3], the distribution of the emitting light can be uniformed. In addition, instead of the V-shaped groove, white paint may be printed in a dot pattern.

[0046]

In addition, there is no problem to insert a prism sheet, a diffusion film sheet, or the like between the light guide plates and the panel for a purpose of increasing the brightness by controlling the view angle of the light emitted in a direction of the panel from the light guide plates [4] and [5] and the diffusing member [6]

or for eliminating bright lines by the V-shaped groove formed on the light guide plates.

[0047]

The space layer between the reflector [7] and the faces [4c] and [5c] that are opposite to the emission faces of the light guide plates is a path to guide light towards the both edges of the light guide plates <The typo is corrected in the translation. "light guiding material" is a term used in the source text.> [4] and [5]. By tilting the reflector [7] so as to make the space layer narrower in a direction away from the light source, the sloped section [7b] on the both edges of the reflector [7] can be omitted.

[0048]

From now on, an embodiment of arranging a number of the above-described light source units and using them as a back light of a liquid crystal panel will be described referring to Figs. 5 and 6. Here, the light source units have similar structure to the one described above, and explanation of the same parts will be omitted.

[0049]

[1] is a transmission-type display panel in which liquid crystal display elements are arranged in a lattice in the display area [A]. [2] is a box-like support frame to support the display panel. In the support frame [2], a

plurality of the light source units (two light source units in the figure) is arranged.

/5

[0050]

A pair of light guide plates [4] and [5] of each light source unit is arranged being a certain distance away from the light source [3], is energized to each other in a direction of widening the space by an energizing member [8] attached at the space on the both edges outside the display area [A], and tightly attached to the light guide plates of the adjacent light source unit.

[0051]

The energizing member [8] may be made of an elastic material such as metal or resin, and is secured on the support member [2]. The lower surfaces of the respective light guide plates [4] and [5] are placed on the sloped face of the support frame [2] via an elastic supporting material such as rubber, which is not illustrated in the figure, and tightly contacts with the backside of the display panel [1].

[0052]

For the direction to arrange the light source units, if they are arranged in the lateral direction of the display panel [1], the number of the light source units may

be less and it is advantageous in view of workability. However, in view of visibility, it is preferred to arrange the light source units in a horizontal direction in a state of using the liquid crystal display device.

[0053]

If the width [P] in the arrangement direction of the light source units is set to the integral multiple of the liquid crystal picture element pitch of the display panel [8], and a connecting section to the adjacent light source unit is set to non-picture element position between picture elements, a bright line or a dark line of the connecting section can be hided.

[0054]

The reflector [7] integrally covers the back sides of the whole light guide plates and is secured onto the support frame [2] being away from the light guide plates. The face of the reflector [7], which faces the light guide plates has inverse V-shaped protrusions [7a] and [7c], which are respectively parallel to the axial direction of the light source [3], right under each light source and right under the connecting section to the light source unit.

[0055]

Since operation of light in the above embodiment is similar to the one described above, the explanation is

omitted. Here, since a plurality of light sources [3] is used, more uniform brightness can be achieved by including an adjusting means for controlling voltage or current for each light source to reduce uneven brightness on the liquid crystal panel [1] due to change or variation in amount of light of the light sources [3].

[0056]

Moreover, needless to say, there is no problem to insert a diffusion film sheet or a lens sheet between the light guide plates and the panel to control the view angle or improve the brightness of the liquid crystal panel.

[0057]

[Effects of the Invention]

As described above, according to the invention, since display on a big screen can be achieved on thinner and lighter liquid crystal display device by disposing in parallel a plurality of light source modules having a light source and a pair of light guide plates, the device can be applied in a large liquid crystal display device such as a big screen TV or wall-mounted TV.

[Brief Description of the Drawings]

Fig. 1 is a lateral sectional view of major parts of an area light source device of this invention.

Fig. 2 is an exploded view of an image display device using the area lights source device of the invention.

Fig. 3 is an illustrative view of a light source unit of the invention.

Fig. 4 is a detailed view near the light source in this invention.

Fig. 5 is a lateral sectional view of a major part of a liquid crystal display device of this invention.

Fig. 6 is an exploded view of a liquid crystal display device of this invention.

Fig. 7 shows a conventional area light source device.

[Description of the Reference Numerals]

1: Display panel

2: Support frame

3: Light source

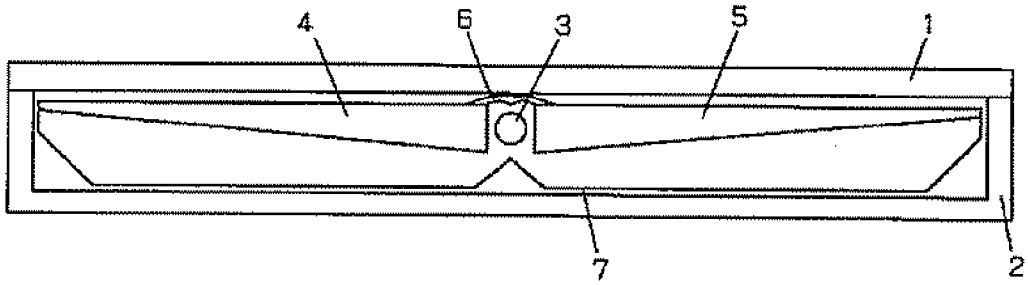
4: Light guide plate

5: Light guide plate

6: Diffusion member

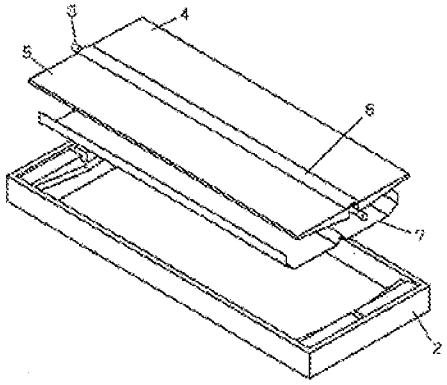
7: Reflector

8: Energizing member

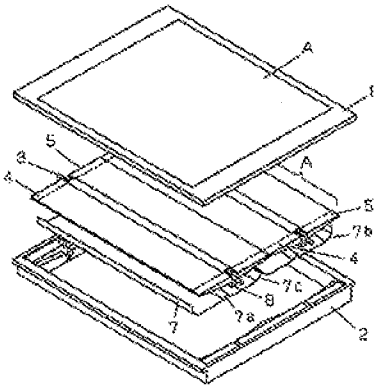


[Fig. 1]

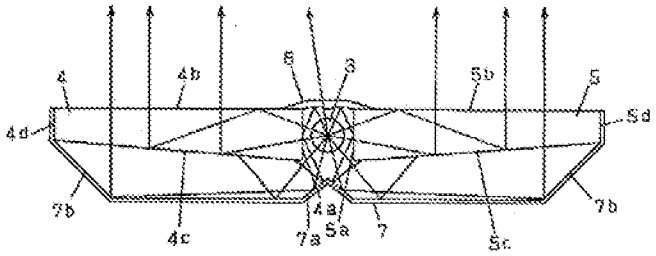
1: Display panel
2: Support frame
3: Light source
4, 5: Light guide plate
5: Light guide plate
6: Diffusion member
7: Reflector



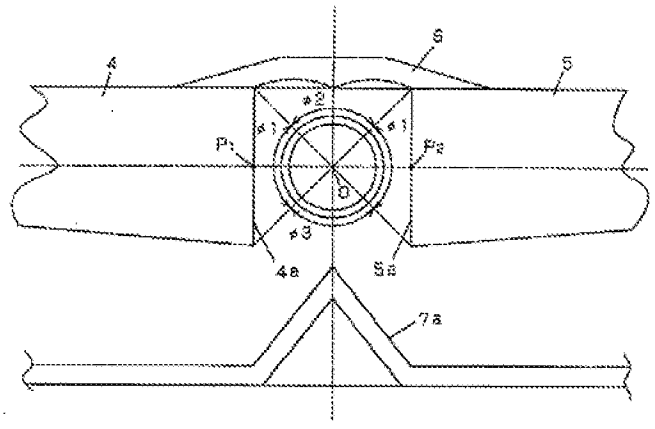
[Fig. 2]



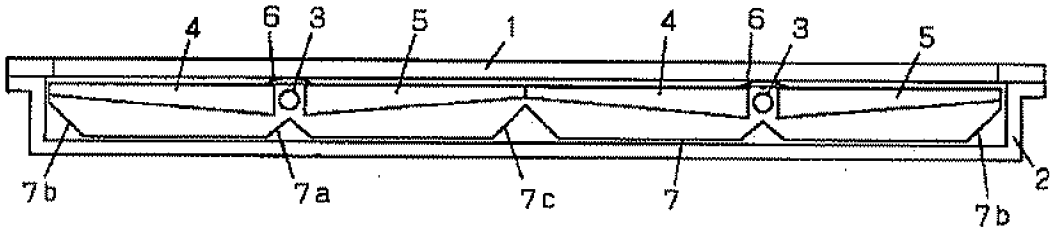
[Fig. 6]



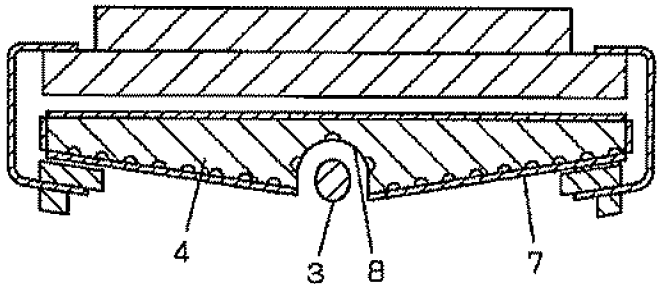
[Fig. 3]



[Fig. 4]



[Fig. 5]



[Fig. 7]

3: Light source
4: Light guide plate
7: Reflector
8: Recess